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WINERY DIRECTIONS

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Three improvements in the methods of fermenting wine are being adopted very widely in Californian cellars. These are: the use of sulfurous acid, of pure yeast, and of cooling devices.

Many inquiries are received at the Station as to the proper methods of applying these improvements, and some failures have been reported in their use. These failures seem to be due to mistakes in the times, quantities, or methods of application. The following directions are intended to prevent these mistakes. They are intended for expert wine-makers, who understand the general processes of wine-making, and who wish to improve their product by the use of these modern methods.

More detailed directions and some of the experiment work on which these directions are based will be found in the following publications of the California Agricultural Experiment Station:

Bulletin 174—A New Wine-Cooling Machine.

Bulletin 213—The Principles of Wine-Making.

Bulletin 230—Enological Investigations.

These may be obtained on application to the Director of the Agricultural Experiment Station, Berkeley, California.

DIRECTIONS FOR THE PRODUCTION OF YEAST STARTERS

A yeast starter is a small quantity of vigorously fermenting must, which is mixed with the crushed grapes or defecated must to start fermentation.

Its uses are to prevent unfavorable fermentations, to insure the presence of a good yeast, and to save time by hastening the fermentation.

Natural Starters.—Must taken from a vat which is undergoing a satisfactory fermentation may be used as a starter. If taken too near the beginning of the fermentation, it will contain a large proportion of undesirable forms of yeast. If taken too near the end, the good

yeast may be weakened and the must may contain many harmful bacteria. The best time to take the starter is after half of the sugar has disappeared but before it has all gone and before the fermentation shows signs of weakening.

Pure Yeast Starters.—A pure yeast starter is one prepared from a yeast of tested qualities and is more reliable than a natural starter. Cultures of pure yeast are supplied by the California Agricultural Experiment Station at Berkeley at a nominal cost.

A starter is made from the culture by increasing the amount of yeast to the required volume by the following means:

1. Increase to one pint with sterilized must supplied with the culture. About 48 hours needed.

2. Increase to 2½ gallons with sterilized must prepared at the winery. About 48 hours.

3. Increase to 40 gallons with defecated must prepared at the winery. About 48 hours.

The following are detailed directions of how to proceed at each step:

1. Two flasks will be received from the laboratory, one marked "Yeast" and the other "Must".

A little alcohol should be poured on to the cotton stoppers of each bottle and ignited. This will destroy mold spores present. The stoppers are then removed and the must poured into the yeast flask, which should be immediately closed with the stopper and placed in a warm place (as near 85° F. as is practicable) and allowed to remain until in vigorous fermentation.

2. When the yeast in the flask is fermenting vigorously, fifty pounds of clean, cold, fresh grapes are crushed and the juice extracted. The grapes need not be very ripe—from 17° to 20° Bal. is favorable. All materials, buckets, hoses, etc., that come in contact with the grapes or must should be washed with boiling water immediately before using. About 2½ gallons of must should be obtained in this way. This should be heated to boiling, cooled and thoroughly aerated by long shaking in a five-gallon demijohn.

When the yeast in the flask is in full fermentation it should be poured into the sterilized, cooled, and aerated must in the five-gallon demijohn, which should then be placed in a warm place, until it is in strong fermentation. The yeast should be added to the 2½ gallons of must the same day that this must is prepared.

3. Obtain 40 gallons of must from clean, fresh, cold grapes not too ripe. Place this in a thoroughly cleaned fifty-gallon barrel and add 2 ounces of potassium meta-bi-sulfite, first dissolved in water. Allow

to settle 24 hours. Draw off the clear must into a half puncheon, small vat, or open fifty-gallon barrel.

Thoroughly aerate this clear must in the vat by repeatedly dipping up a bucketful and pouring it back. Meanwhile heat a portion of the must nearly to boiling and mix it with the cool must in the vat. The mixture should have a temperature of about 80° F.

Add the strongly fermenting must from the five-gallon demijohn to the aerated and warmed must in the vat and cover with a cloth to keep out dust and maintain the heat. Aerate three or four times a day until the fermentation is going well.

When half the sugar has fermented out, the must is ready to use as a starter. The 40 gallons are enough to start a vat containing 10 or 12 tons of grapes.

Maintenance of the Starter.—The simplest method is to start a large vat with the starter obtained as above and to start later vats from this one. New vats are thus started from older vats in full fermentation, as already described for natural starters. This method has been found very satisfactory in many wineries and can be recommended where most of the grapes received are in good condition.

For wineries which receive grapes from long distances, especially by rail, it is better to install a simple pure yeast apparatus such as that described on pages 72 to 86 of Bulletin 230, above referred to.

DIRECTIONS FOR DRY RED WINE FERMENTATION

1. *Filling Vats.*—Vats should be filled to not more than four-fifths of their height. The layer of crushed grapes should not be more than four feet deep. Grapes should be ripe (about 22° Bal.) and cool (about 65° F.).

2. *Sulfiting.*—Add potassium meta-bi-sulfite *during* or *immediately after* crushing, distributing it equally throughout the vat. Use an average dose of 8 ounces per ton or from 6 ounces to 12 ounces, the larger amounts for very sweet grapes and hot weather, the smaller amounts for acid grapes and cool weather. The sulfite is conveniently used as a solution, made by dissolving one pound of the sulfite in one gallon of water. Half a pint of this solution contains one ounce of sulfite.

3. *Records.*—Test the Balling degree and the temperature of the must as soon as the vat is filled. As soon as fermentation commences, these tests should be made again and repeated at least twice every twenty-four hours while the grapes are in the vat. A record of these tests, showing the date and hour made, should be kept both in a book and on the vats where they can be referred to easily. This record is

the wine-maker's guide. It shows him how the fermentation is progressing and when to carry out the various operations.

4. *Addition of Yeast Starters.*—About six hours after sulfiting, add four gallons of strongly fermenting must to each 200 gallons, or each ton, of crushed grapes. If the grapes are warm, the yeast should be added within three hours. Two gallons of yeast is sufficient in hot weather; eight gallons is better in cold weather. The best starter is one taken from a simple pure yeast apparatus such as that described on page 81 of Bulletin 230. Where this is lacking, use a starter from a vat in full fermentation in which the sugar degree has fallen to between 4° and 8° Bal.

The yeast should be well mixed by "punching," or better by "pumping over."

5. *Covering.*—In a clean, well managed cellar, no cover is needed for the vats. If used at all, it should be removed as soon as perceptible fermentation commences.

6. *Stirring.* As soon as the fermentation is evident the contents of the vat should be well stirred by punching or pumping over at least twice a day. The objects are to equalize the temperature, to promote extraction of color and tannin and to aerate the must. Aeration must not be excessive, especially during the violent fermentation The sugar and temperature records should be made immediately after stirring.

7. *Cooling.*—The best red wines are made when the temperature does not rise above 90° F. Temperatures above 95° F. notably decrease the quality. Where cooling devices are available, they should be used as soon as or a little before the temperature reaches 90° F. The amount of cooling necessary will depend on the amount of sugar left, the size of the vats and the temperature of the air. If the cooling is done when the vat reaches 90° F., the amount of cooling needed will be approximately 1.5° F. for each Bal. degree left. That is, a vat which still shows 8° Bal. when the temperature reaches 90° F. should be cooled about 12 degrees. This cooling may be done in one or two operations.

8. *Drawing-off.*—The time for separating the wine from the pomace by drawing-off and pressing is determined by the extraction of tannin and color. The amount of sugar left has nothing to do with it. Fermentation will finish as well after as before drawing-off. The maximum color is usually obtained after about 72 hours of actual fermentation on the skins. In hot fermentations 48 hours are sufficient for this purpose; in cold fermentations it may require four or five days. Sufficient tannin is usually extracted in the same time, but with

a few varieties of grapes, or if very astringent wines are desired, they may be left one or two days longer in the vat. In properly conducted fermentations, the time from filling the vats to drawing off the wine will range between three and five days.

9. *After Fermentation.*—When the wine is drawn off, whether it shows sugar or not by the Balling saccharometer, it nearly always still contains fermentable sugar. The fermentation must not be checked, but should continue without interruption until completely finished. This is accomplished by aeration and maintaining the temperature. Drawing-off stimulates the fermentation by exposing the wine to the air. This is often sufficient. If not and the wine still shows a remnant of sugar to the taste two days after being placed in storage casks, it should be well aerated by pumping over. This aeration should be repeated every two or three days if necessary until the wine has lost all its sugar. In from seven to fourteen days from crushing, all red wines should be completely dry. During this time the wine should not be allowed to become too cool. It is well to store it for the after fermentation in large casks in the warmest part of the cellar.

10. *Removal of Yeast.*—When the wine is dry, the yeast has done its work and should be removed as soon as possible. It will settle completely in a few weeks and the wine should be racked off the sediment into clean slightly sulfured casks in the coolest part of the cellar. The smaller the casks the more rapidly and the more perfectly the wine will clear during the winter.

DIRECTIONS FOR DRY WHITE WINE FERMENTATION

1. *Crushing and Pressing.*—White grapes should be a little riper than red and should be crushed as cool as possible. Pressing should be rapid to avoid fermentation.

2. *Sulfiting.*—Somewhat less sulfite is needed for white than for red grapes. A dose of 6 ounces per ton is usually sufficient. This may be increased to 8, 10, or 12 ounces for sweeter grapes or for grapes in poor condition, and in hot weather. The sulfite is best applied to the crushed grapes as they run from the crusher.

3. *Defecation.*—The must is first run into a shallow settling vat. If the crushed grapes have not been sulfited, from 3 to 4 ounces of sulfite should be added to each 100 gallons of must. In closed casks about 2 ounces of sulfur may be burnt per 100 gallons of must instead of using sulfite. After settling for 24 to 48 hours, the clear must is drawn off the sediment into the fermenting vats or casks. In this

transfer the must should be well aerated by allowing it to splash into the pump sump.

4. *Addition of Yeast Starters.*—The yeast is added as in red wine, and as soon as the must is taken from the defecating vats.

5. *Records.*—At least once a day the sugar and temperature should be tested and a record made on the outside of the vat or cask.

6. *Cooling and Aeration.*—The fermentation of white wine is always much slower than that of red and the temperature usually does not rise so high. White wines, however, are more easily injured by high temperatures than red. The wine is best if the maximum temperature does not exceed 75° F. Where fermentation takes place in puncheons, no cooling is needed, as a rule. In large casks or vats it is desirable. Open vats for the violent fermentation are better than closed, as they allow more heat to escape.

7. *After Fermentation.*—The main fermentation will require from four to seven days, according to the temperature, if a starter is used. If the wine is not nearly dry in this time, it requires aeration. This may be given by pumping over. In from ten days to three weeks the wine should be perfectly dry, unless the temperature has been kept very low. If the last remnants of sugar are slow in disappearing, two or three aerations by pumping over should be given.

8. *Removal of Yeast.*—White wine is a little slower in clearing than red, but within two or three weeks from the time it tastes dry it should be racked from the yeast and sediment into clean, slightly sulfured casks and stored in the coolest part of the cellar.

TABLES OF AVERAGE YIELDS

The yields of the various products of the winery vary considerably, according to the nature of the raw material and of the methods of handling. A knowledge of the average yields and the ordinary variations from these yields is useful to the wine-maker, as a means of testing the efficiency of his methods of wine making. The following data are based on observations and measurements under ordinary conditions in Californian wineries. The data regarding quantities are based on experiment and the practices of the best wine-makers.

VOLUME OF A TON OF GRAPES

	Maximum	Minimum	Average
Fresh grapes before crushing, cu. ft.	55.66	47.70	52.43
Grapes after crushing and stemming, cu. ft.	30.10	21.50	26.47
Decrease, per cent	59.50%	41.39%	49.50%

Yields of a Ton of Grapes

	Maximum	Minimum	Average
Stems (from crusher)	64.6 lbs.	16.2 lbs.	27.2 lbs.
Pomace, unfermented	513.0 lbs.	265.0 lbs.	391.0 lbs.
Pomace, fermented	392.1 lbs.	252.0 lbs.	345.2 lbs.
Fresh juice	183.4 gals.	160.4 gals.	168.7 gals.
White wine, new	..... gals.	..... gals.	151.0 gals.
White wine, after racking	..... gals.	..... gals.	145.5 gals.
Red wine, free run	143.0 gals.	127.8 gals.	136.4 gals.
Red wine, from press	43.1 gals.	34.7 gals.	38.4 gals.
Red wine, total	179.5 gals.	170.9 gals.	174.9 gals.
Red wine, after first racking	..... gals.	..... gals.	169.0 gals.

Temperature Corrections for Balling Saccharometer

Observed Bal.	T 60	65	70	75	80	85	90	95	100	105	110 Fahr.
10	0	.18	.35	.54	.72	.93	1.22	1.47	1.72	1.97	2.22
11	0	.18	.35	.54	.72	.94	1.22	1.47	1.73	1.98	2.23
12	0	.19	.35	.54	.72	.94	1.23	1.48	1.73	1.98	2.23
13	0	.19	.36	.55	.73	.95	1.23	1.49	1.74	1.99	2.24
14	0	.19	.36	.55	.73	.96	1.24	1.49	1.76	2.00	2.25
15	0	.19	.37	.56	.74	.97	.124	1.50	1.77	2.01	2.26
16	0	.20	.37	.56	.74	.98	1.25	1.50	1.77	2.01	2.27
17	0	.20	.37	.56	.75	.98	1.27	1.51	1.78	2.02	2.28
18	0	.20	.38	.57	.75	.99	1.28	1.52	1.79	2.03	2.29
19	0	.20	.38	.57	.75	.99	1.29	1.53	1.79	2.03	2.30
20	0	.20	.38	.58	.76	.99	1.30	1.54	1.79	2.04	2.31
21	0	.20	.38	.58	.76	.99	1.30	1.54	1.80	2.05	2.32
22	0	.21	.39	.59	.76	1.00	1.30	1.55	1.80	2.05	2.32
23	0	.21	.39	.59	.77	1.00	1.31	1.55	1.81	2.06	2.33
24	0	.21	.39	.59	.77	1.00	1.31	1.56	1.81	2.07	2.34
25	0	.21	.39	.59	.77	1.01	1.32	1.56	1.82	.207	2.34
26	0	.22	.40	.60	.78	1.02	1.32	1.57	1.82	2.08	2.35
27	0	.22	.40	.60	.78	1.02	1.33	1.57	1.83	2.09	2.36
28	0	.22	.40	.60	.79	1.02	1.34	1.58	1.83	2.09	2.36
29	0	.22	.40	.61	.80	1.03	1.34	1.58	1.84	2.10	2.37

Add the number corresponding to observed temperature to the observed Balling degree.

Approximate correction:

For each 10° F. above 60° F. add .4° Bal.

For each 25° F. above 60° F. add 1° Bal.

BALLING AND SUGAR OF MUST AND ALCOHOL OF WINE

(Based on Californian Analyses)

Balling	Sugar in Must	Achohol in Wine
19	18.64	10.9% by vol.
20	19.47	11.5% by vol.
21	20.35	12.0% by vol.
22	21.34	12.5% by vol.
23	22.36	13.2% by vol.
24	23.31	13.8% by vol.
25	24.49	14.5% by vol.
26	25.44	15.1% by vol.
27	26.42	15.6% by vol.

Approximate estimate.—Alcohol by volume in fermented wine = 57.5 per cent of Balling per cent of must.

NOTES ON WINE FERMENTATION

1. A maximum temperature of 90° is favorable for red wine.

2. A maximum temperature of 75° is favorable for white wine.

3. Sulfurous acid is not a means of controlling temperature.

4. Potassium meta-bisulfite is about half sulfurous acid, all of which is available.

5. Sulfur when burned yields about twice its weight of sulfurous acid, only half of which is available with the usual methods of application.

6. Sulfurous acid added to unfermented must or grapes disappears rapidly. It disappears more slowly from fermented wine.

7. In treating wine only about one-tenth the amount of sulfurous acid should be used as is used in treating crushed grapes.

8. Sulfurous acid prevents the action of injurious fermentations. Pure yeast starters insure the action of beneficial fermentation.

9. Aeration and heat stimulate fermentation.

10. The best fermentation is one which continues without interruption until all sugar has disappeared.